Feather River Fish Hatchery Otolith Thermal Marking Program

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In order to assess the success of recovery programs for Central Valley Chinook salmon it is exceedingly important to identify the origin (hatchery or naturally produced) of salmon within the spawning population. Previously, tagging the fish with coded-wire tags was our only method of identification. Unfortunately, only a small percentage of the fish were tagged. This weakened our ability to accurately determine the race and the portion of hatchery fish comprising the run. Thermal marking provides an efficient means of marking 100% of the fish produced at the hatchery. It allows us to take any salmon in the river, remove its otoliths and determine if it is a hatchery fish or not.

The otoliths, found in pairs and located beneath the brain, are composed of calcium carbonate and protein. Otoliths consist of calcium carbonate and protein layed down daily in a pattern of rings similar to that of trees. Researchers discovered that external factors such as temperature influence these patterns. By manipulating the water temperature in the incubators (or stacks), we can place a series of rings on the otoliths that will identify them by hatchery and brood year. This process forms a type of "bar code" on the otolith that remains with the fish for its lifetime. These patterns of bands can be customized for each hatchery and brood year by varying the number of bands and the width and spatial placement of these bands.

The Chinook salmon run in the Feather River consists of Central Valley spring run and fall run; both heavily supplemented by the Feather River Fish Hatchery (FRFH). In order to more effectively determine the composition of the run (spring vs. fall) and the origin of the fish (hatchery v. naturally produced), the Department of Fish and Game (DFG) and the Department of Water Resources (DWR) developed an otolith thermal marking program (OTM) for the Feather River Fish Hatchery. A pilot study was initiated in 2003 where we experimented with different mark patterns, duration, and spacing on a small portion of the production. In brood 2005/06 we began 100% marking of spring and fall run Chinook at the hatchery. The following brief describes the results of our pilot study. Results for the full implantation program are yet to be determined.

In the fall of 2003, we experimented with thermally marking otoliths for two different lots of fish; one prior to hatch (FR 27) and one prior to and after hatch (FR 20). The mark consisted of 4 equally spaced four hour chilled water treatments (Figure 1). For each mark period, the water temperature was lowered approximately 2.2 ^{o}C.

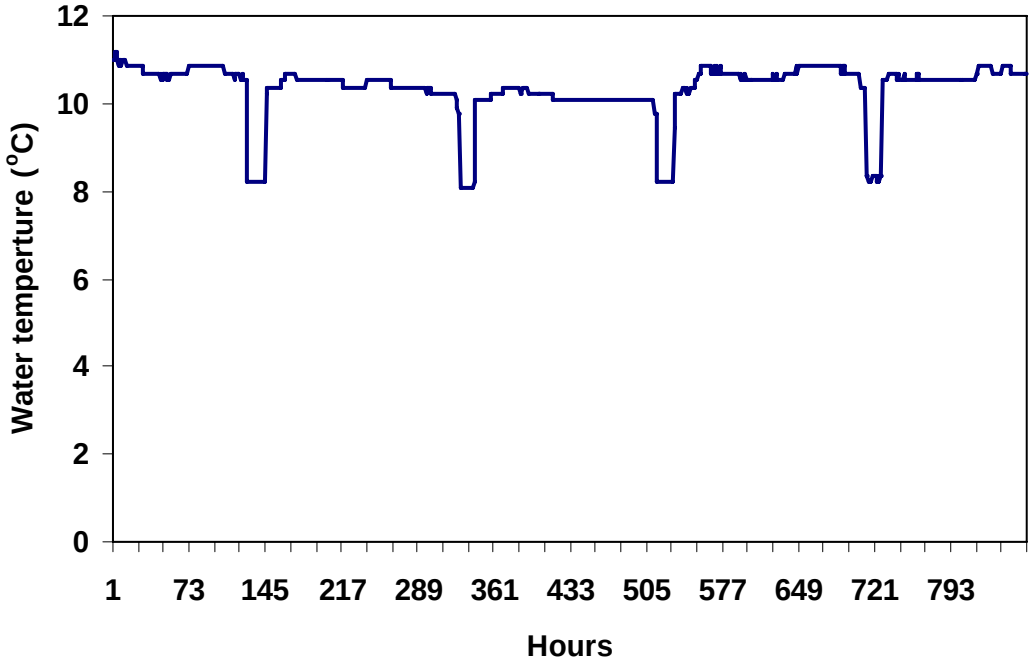

Figure 1. Water temperature profile during mark period.

Our first experiment demonstrated that the FRFH had the logistical means to thermally mark otoliths. The 4 four hour treatments left identifiable marks in both the pre hatch and post hatch region of the otolith and the mark pattern corresponded well to the chilled water treatments. However, the pattern was not as easy to identify as we had hoped. Also, we desired greater flexibility in tag patterns than we could get with a 4 mark tag.

In the fall of 2004, we employed a 6 mark tag system to provide greater flexibility in tag patterns. Four different lots of fall run Chinook were marked; FR 14, FR 15, FR 16, and FR 17. In order to identify race, we experimented with two different marks within the post hatch region (Table 1). To indicate brood year, we experimented with a simple mark pattern within the pre hatch region of the otolith (Table 1).

Table 1. Mark patterns for the 2004/05 brood year.

Hatchery Lot	Otolith Region	
	Pre Hatch	Post Hatch
14	)))	))))))
15	)))	))))))
16		))))))
17		))))))

Results from the 2004/05 experiments showed that we could successfully mark fish using a simple brood year mark and a more complex 6 pattern mark (Figure 2 and 3). Unfortunately, we also discovered that the chiller at the FRFH had a limited capacity and could not chill as many lots at one time as we anticipated. Therefore, we thought that the combination of pre hatch and post hatch marks during 100% marking was not a viable option. For full implantation, we decided to use six different marks each one indicating brood year and race for the fish produced at the FRFH.

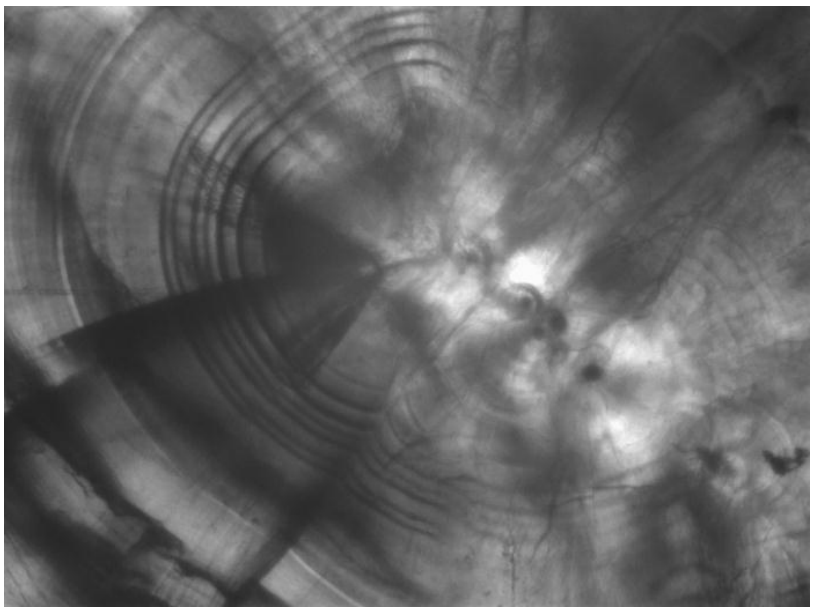

Figure 2. A picture of Chinook otolith from lot 16 showing a mark pattern (1,3,2) in the post hatch region.

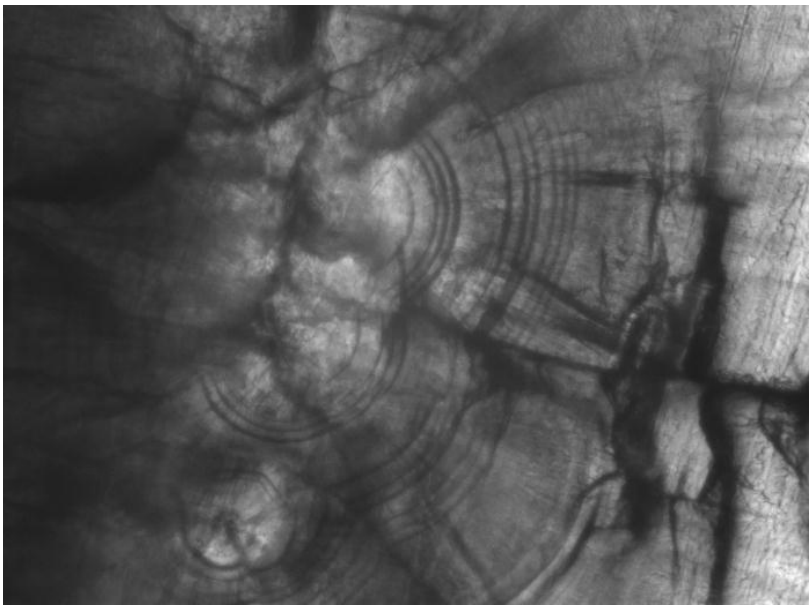

Figure 3. A picture of Chinook otolith from lot 15 showing the pre hatch brood mark (3) and the post hatch mark (1,2,3).

In 2005/06, we began full 100% marking of spring and fall run Chinook. In 2007/08, we completed our third season of mass marking at the FRFH. This year also is the first season that OTM fish began returning to the Feather River, as jacks (two year olds). Unfortunately, the 2007/08 spawning population was extremely low and very few jacks were recovered. In the following years additional brood years will be returning, such that by 2009/2010 the entire cohort of spawning salmon will be thermally marked (ages 2 through 5 yeas). With the continuation of this program we will be able to definitively determine the origin and the portion of spring and fall run within the river and the hatchery. With known origin and race, we can then employ more advanced otolith analyzing techniques to also investigate potential differences in life history strategy for fall and spring run, as well as hatchery and naturally produced Chinook. This will be valuable information to evaluate the effectiveness of past management decisions aimed at the recovery of natural origin Chinook, as well as a guide for future restoration actions.